Tracheostomy Tube Ignition During Microlaryngeal Surgery Using Diode Laser: A Case Report

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Ignition of the tracheal tube during laser microlaryngeal surgery under general anesthesia is an uncommon complication with potentially serious consequences. We present here a case of a patient with glottic stenosis following endotracheal intubation, who experienced this potentially catastrophic combustion during endoscopic arytenoidectomy, using a diode laser under general anesthesia via 60% FiO_2, with an airway fire occurring at the tracheostomy tube and causing tubal damage and obstruction. The anesthetic connecting tube was immediately disconnected and the tracheostomy tube replaced. No adverse consequences to this patient's upper airway were noted during follow-up visits. Higher oxygen concentrations, the presence of combustibles, and the narrowness of the surgical field during endolaryngeal diode laser surgery are risk factors for airway fires.

Key Words: ignition, anesthesia, complication, diode laser, microlaryngeal surgery
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Endotracheal explosion and fires caused by coherent irradiation in the endotracheal tube are well-known complications of laser surgery [1]. The reported occurrence rate for ignition during this type of surgery ranges from 0.14% to 1.5% [2]. Despite the different laser types used for the various surgical procedures, the biophysical fundamentals remain the same. The most frequently reported airway fires involve CO_2 lasers. We present the first such case involving the diode laser.

Case Presentation

A 53-year-old male suffering from diabetic ketoacidosis, and with a history of intubation resuscitation 5 years earlier, developed glottic stenosis as a late complication. He had undergone tracheostomy and microsurgical resection of the laryngeal scar 9 months previously. Because the glottic stenosis was not adequately controlled, he was admitted for a second endoscopic microlaryngeal surgery, using a diode laser (DIOMED 15 PLUS, UK).

Before the procedure, the patient was given 10 mg of metoclopramide and 0.4 mg of atropine sulfate intramuscularly. Anesthesia was induced with propofol 150 mg, lidocaine HCl 40 mg, fentanyl 100 μg, and atracurium 10 mg. Maintenance of anesthesia was facilitated with sevoflurane, air, and oxygen (60% by volume) delivered via a No. 7.5 polyvinylchloride cuffed tracheostomy tube. A diode laser (at 6 W) transduced by an optic fiber was used in contact mode to excise the granulations and scarring in the larynx. Unfortunately, a fire was ignited inside the tracheostomy tube and the distal lumen of the anesthetic connecting tube during the surgical procedure. The distorted tracheostomy tube (Figure 1) was removed immediately and subsequently replaced with a new tracheostomy tube. Subsequent fiberscopic examination of the distal tracheal wall revealed good patency and only mild edematous mucosa without burn injury down to the carina.

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The arytenoidectomy was completed at reduced laser power (4 W) and oxygen concentration (40%). Intravenous hydrocortisone 100 mg was given intraoperatively.

In order to prevent infection, the patient received postoperatively 2 mg of betamethasone every 8 hours for 2 days, 1 g of cefazolin sodium every 8 hours for 3 days, and a bolus of 160 mg of gentamicin sulfate every 24 hours for 3 days. Follow-up chest X-ray was normal, and the patient remained afebrile. At the first follow-up on the 10th postoperative day, no evidence of thermal injury was detected in the larynx or trachea by fiberoptic laryngoscopy (Figure 2). The patient was in good health throughout the 2-year follow-up.

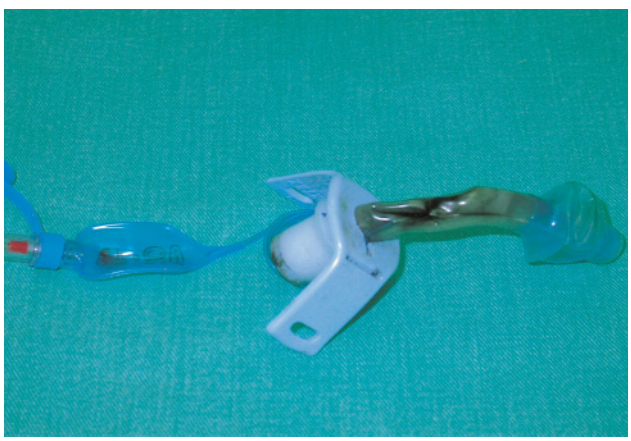

Figure 1. *Distorted tracheotomy tube with near occlusion of lumen after the fire.*

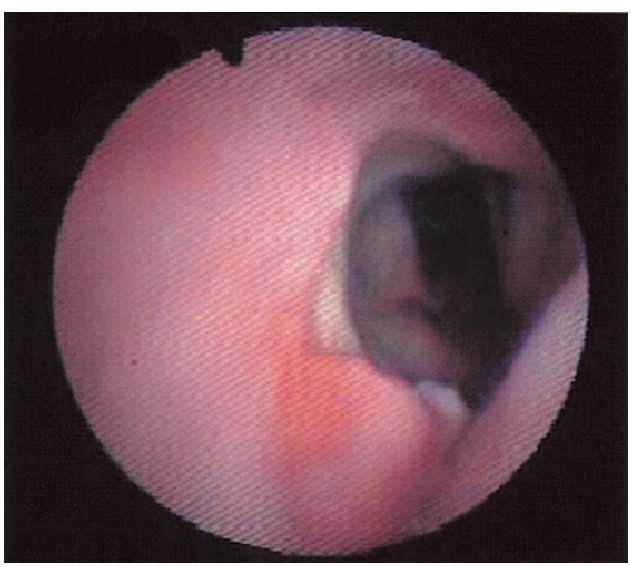

Figure 2. *Endoscopic view at tracheostomy site. No debris deposition and only mild edematous mucosa were noted.*

Discussion

The CO_2 laser with a wavelength of 10,600 nm, which has the most favorable properties for soft-tissue excision, is frequently used in management of otolaryngologic disorders, particularly for treatment of laryngeal lesions [3–6]. The diode laser has also recently been used in minimally invasive surgery and various otolaryngologic disorders. It induces excellent hemostasis as a result of the high absorption in melanin and hemoglobin in the near-infrared portion of the spectrum (810 nm) [7].

The most prevalent variant of airway fire during laser laryngeal surgery is ignition of the endotracheal tube [8]. Explosion may also occur, with injury severity much greater than that for ignition. Schramm et al reported one patient whose endotracheal tube explosion resulted in distal dislodgement of the tip of the endotracheal tube into the patient's left main-stem bronchus, causing intraalveolar edema, hemorrhage, and diffuse atelectasis [4]. In our patient, the largely uncomplicated and less severe airway fire was due to an ignition of relatively short duration without explosion. Immediate removal of the melted plastic tube can decrease physical contact and toxic smoke inhalation injury.

In contrast to the CO_2 laser, the diode laser is more often used in contact mode. For both of the two laser systems, the classic elements for an airway fire are similar: oxygen, combustibles, and energy source [1]. The risk has been reported to increase in proportion to oxygen concentrations above 50% [1,3,4]. With respect to the combustibles, the types of tracheal tubes used in laser surgery include items made from polyvinyl chloride, red rubber, silicone, and stainless steel. Although laser-resistant endotracheal tubes are preferable, they are expensive and may not be readily available in some countries. Because there is no laser-resistant tracheostomy tube, the non-laser-resistant tube must, therefore, be protected by metal foil or saline-soaked cotton pledgets around the intratracheal portion of the tracheostomy tube during use. The metal foil is reflective, so any hot spots induced by the laser should be less intense [9]. However, a reflected laser beam can still damage nontargeted tissue. Saline-soaked cotton pledgets dissipate the high, localized heat of the laser beam induced during surgery [5]. By comparison, the inexpensive and most readily available polyvinyl chloride tubes are more flammable at a relatively low temperature, increasing the risk of airway fire during a laser procedure [1,4,5].

For this particular patient, the reasons that we used a diode laser instead of a CO_2 laser were mainly its availability and price of the equipment. The endoscopic laryngeal laser

procedure was carried out initially under a relatively higher oxygen concentration (60%) without nitrous oxide, delivered via a polyvinyl chloride tracheostomy tube covered with saline-soaked cotton pledgets for protection. The relative high oxygen concentration, displacement of the protective cotton pledgets resulting in tube exposure, and the narrow microsurgical field may all have contributed to the tracheostomy tube fire.

Proper management for a tracheostomy tube fire may reduce postoperative morbidity, as demonstrated in this particular patient. Immediate management for this catastrophic condition involves urgent replacement of the damaged tracheostomy tube and disconnection of the anesthetic connecting tube. Because high-temperature fumes from the burnt polyvinyl chloride tube may result in subglottic, bronchopulmonary damage producing bronchial stenosis and atelectasis [4, 5], bronchoscopic evaluation is indispensable intraoperatively. Postoperative medical treatments include airway monitoring, adequate high-humidity oxygen, pulmonary assessment, and prophylactic antibiotic administration for prevention of infection.

In summary, airway fire during microlaryngeal laser surgery may be induced by the diode laser as well as the more commonly used CO_2 laser. It is vitally important, therefore, that both surgeon and anesthesiologist understand and anticipate the major risk factors for this catastrophic combustion, as well as the immediate management for this potentially serious complication.

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二極體雷射於喉部顯微手術使用時所導致之氣切管著火：病例報告

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在全身麻醉下，使用雷射從事於喉部顯微內視鏡手術，所導致的氣管內管著火是一種可能導致嚴重後果但不常見的併發症。我們報告一位因氣管插管所導致的真聲帶狹窄病例，在氧氣分率 60% 的全身麻醉下，使用二極體雷射從事內視鏡披裂軟骨切除手術時，發生氣切管著火。在立即移除麻醉連接管，以及重新置放一個新的氣切管後，完成預計之手術。病人在術後的門診追蹤，並無上呼吸道之副作用產生。較高的氧氣濃度、助燃物的存在，以及狹窄的手術視野是從事二極體雷射喉內視鏡手術之危險因子。

關鍵詞：著火，麻醉，併發症，二極體雷射，喉部顯微內視鏡手術

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